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Research Article

Hoverflies (Diptera, Syrphidae) in a rural garden and their potential for citizen science

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Abstract

In a rural garden in the southwest of the Netherlands, 48 species of hoverfly were observed, belonging to 28 genera. All but one species are common in the Netherlands. Gardens are a natural habitat for many hoverflies. Both species diversity and the abundance of hoverflies can be high, making hoverflies good indicators for an ecological garden health index for insects. The potential contribution of citizen science to gain more ecological knowledge of hoverflies in gardens is discussed. This study shows that photographic capture and biometrical identification are suitable for citizen science projects on hoverflies.

Key Words

backyard, biodiversity, biometrical identification, decline of insects, photographic capture, suburban garden, syrphids

Introduction

The reduction of insect biodiversity is a global problem (Hallmann et al. 2017; Sánchez-Bayo and Wyckhuys 2019) and, more specifically, the decline of hoverflies has been demonstrated (Gatter et al. 2020; Barendregt et al. 2022; Reemer et al. 2024; Zeegers et al. 2024). All measures that may reverse this downward trend should be investigated. Gardens may play an important role in increasing insect biodiversity by offering diverse habitats, ecological corridors, or as refugia as well as food supply for nearby areas (Gaston et al. 2005; Davies et al. 2009; van der Velden 2021; Bishop et al. 2024). Limited information is available on the conditions of garden microhabitats in relation to the autecology of insects (Smith et al. 2006b). In recent years, especially during and after the COVID-19 pandemic, there has been significant attention on the ecological condition of private gardens (van der Velden 2021, 2022; Hoogenstein 2023), and it has been concluded that the biodiversity of gardens is higher than expected.

Hoverflies consist of many species and are an abundant presence in gardens (Owen and Gilbert 1989; Baldock et al. 2019). They serve as good indicators for the environmental quality of rural areas (Smith et al. 2006a; Reemer et al. 2009; Popov et al. 2017). However, the number of published studies on the presence of hoverflies in rural gardens in Europe is limited. Owen and Gilbert (1998) reported about 90 species of hoverflies during 15 years of monitoring in a suburban garden in England. In Sweden 33 species were found in 14 rural gardens and 20 species were found in 39 urban gardens (Persson et al. 2020); it was concluded that hoverflies were more species-rich in rural than in urban gardens. Jankowska and Wojciechowicz-Zytko (2011) reported 40 species in a botanical garden in Poland, and Van de Meutter and Mortelmans (2023) reported 114 species in a botanical garden in Belgium.

Citizen science could make a major contribution to gather information on hoverflies, garden characteristics and the relation between these factors to help understand how to best create and manage gardens for insect biodiversity. This study looks at the potential for citizen

science focussed on hoverflies to create a future qualitative garden health index for biodiversity by collecting information on hoverflies in gardens.

Methods

To determine the suitability of hoverflies as indicators for biodiversity and for citizen science projects, a private rural garden in Kloetinge (Figs 1–7), The Netherlands, province Zeeland, municipality of Goes (DDM 51°49.63'N, 3°92.23'E) was qualitatively monitored from 2020 to 2023 for the presence of adult hoverflies. The focus was on the presence of species each year. The frequency of monitoring was at least half an hour per week in autumn and winter, and at least one-and-a-half hours per week in spring and summer. Monitoring was carried out by photographic capture and biometrical identification, with validation using the service of Observation International in the year of monitoring (Observation International 2024). All validated observations were entered into the observation database. The rural garden, about 2000 m^2, contains several fruit trees and scrubs, native and non-native flora as well as a small pond. The soil of the garden consists of marine clay and peat. More detail about the garden is given by van der Velden (2021).

Results

During 2020–2023, 48 taxa (under which 46 species) of hoverflies belonging to 28 genera were photographed and identified (Table 1). Despite the high frequency of monitoring, only 17 out of 48 taxa (35%) were found each year. 23% were found only in one year and 42% were found in two or three years. Except for one, all species are designated as common; only *Pipiza festiva* is designated as rare (Reemer et al. 2024). All species are designated as native in the Netherlands (Reemer et al. 2024).

All taxa were identified by photographing the individuals and using the services of Observation International (2024). Two taxa (*Eumerus* sp. and *Pipizella* sp.) could only be identified to genus level; all the other taxa (46) were identified to species level with an approved validation. For taking the photos, knowledge of the identification characteristics of hoverflies is useful.

Following the habitat classification by Reemer et al. (2009), 10 species are indicators for open habitat, 20 species for forest habitat, 3 species are indicators for gardens and parks and 13 species are considered ubiquitous. 11 species indicate the presence of water in the area (Speight 2017) and 40 species are typical for urban habitats (Reemer et al. 2009).

Figures 1–7. Rural garden in the Dutch village of Kloetinge (municipality of Goes), where the syrphid fauna was qualitatively analysed between 2020 and 2023.

Table 1. The presence of hoverflies (Syrphidae) in a rural garden in The Netherlands from 2020 to 2023.

Species	2020	2021	2022	2023	Total period	Each year
Cheilosia albitarsis (Meigen, 1822)	x	x		x	x	
Cheilosia caerulescens (Meigen, 1822)			x	x	x	
Cheilosia pagana (Meigen, 1822)	x			x	x	
Dasysyrphus albostriatus (Fallén, 1817)			x		x	
Epistrophe eligans (Harris, 1780)	x	x	x	x	x	x
Epistrophe melanostoma (Zetterstedt, 1843)		x			x	
Epistrophe nitidicollis (Meigen, 1822)			x	x	x	
Episyrphus balteatus (De Geer, 1776)	x	x	x	x	x	x
Eristalinus aeneus (Scopoli, 1763)	x	x	x	x	x	x
Eristalinus sepulchralis (Linnaeus, 1758)	x	x	x		x	
Eristalis arbustorum (Linnaeus, 1758)	x	x	x	x	x	x
Eristalis nemorum (Linnaeus, 1758)		x		x	x	
Eristalis pertinax (Scopoli 1763)	x	x	x	x	x	x
Eristalis similis (Linnaeus, 1758)	x	x			x	
Eristalis tenax (Linnaeus, 1758)	x	x	x	x	x	x
Eumerus sp. Meigen, 1822		x		x	x	
Eupeodes corollae (Fabricius, 1794)	x	x	x	x	x	x
Eupeodes latifasciatus (Macquart, 1829)				x	x	
Eupeodes luniger (Meigen, 1822)		x		x	x	
Helophilus hybridus Loew, 1864	x				x	
Helophilus pendulus (Linnaeus, 1758)	x	x	x	x	x	x
Helophilus trivittatus (Linnaeus, 1805)	x	x	x		x	
Melanogaster hirtella Loew, 1843			x	x	x	
Melanostoma mellinum (Linnaeus, 1758)		x	x	x	x	
Melanostoma scalare (Fabricius, 1794)			x	x	x	
Meliscaeva auricollis (Meigen, 1822)	x	x	x	x	x	x
Merodon equestris (Fabricius, 1794)	x	x			x	
Myathropa florea (Linnaeus, 1758)	x	x	x	x	x	x
Neoascia podagrica (Fabricius, 1775)		x			x	
Pipiza festiva Meigen, 1822			x		x	
Pipiza noctiluca (Linnaeus, 1758)	x				x	
Pipizella sp. Rondani, 1856	x	x			x	
Platycheirus albimanus (Fabricius, 1781)	x	x	x		x	
Rhingia campestris Meigen, 1822	x	x	x		x	
Scaeva pyrastri (Linnaeus, 1758)			x	x	x	
Scaeva selenitica (Meigen, 1822)	x				x	
Sphaerophoria scripta (Linnaeus, 1758)	x	x	x	x	x	x
Syritta pipiens (Linnaeus, 1758)	x	x	x	x	x	x
Syrphus ribesii (Linnaeus, 1758)	x	x	x	x	x	x
Syrphus torvus Osten Sacken, 1875	x	x	x	x	x	x
Syrphus vitripennis (Meigen, 1822)	x	x	x	x	x	x
Tropidia scita (Harris, 1780)	x	x	x	x	x	x
Volucella bombylans (Linnaeus, 1758)		x	x	x	x	
Volucella pellucens (Linnaeus, 1758)				x	x	
Volucella zonaria (Poda, 1761)	x			x	x	
Xanthandrus comtus (Harris, 1780)			x		x	
Xanthogramma pedissequum (Harris, 1780)			x		x	
Xylota segnis (Linnaeus, 1758)	x	x	x	x	x	x
Number of species per period	**30**	**32**	**32**	**32**	**48**	**17**

Discussion

Hoverflies in gardens

In the garden under study, 48 taxa were identified during the research period. Given that the species found in only a single year are 23% of the total number, and that two new species were observed in the fourth year of monitoring, it is likely that the total number of species which could be found in this garden is somewhat higher than 48. The expected increase may result from missing species during the research period, as well as changing species distribution.

The garden under study shows a large variation of species between years. Only 35% of the species were found every year. Such variation in hoverfly presence has also been observed by de Groot et al. (2022) in urban forest habitats. The variability can be caused by migration behaviour (Ball and Morris 2000; Reemer et al. 2009; Speight 2017; Wotton et al. 2019; Gatter et al. 2020). The absence in some years of species such as *Scaeva pyrastri* and *Helophilus trivittatus* may be caused by the fact that

these are migratory species without permanent breeding populations (Ball and Morris 2000). Another possible explanation for the observed variation includes differing annual abiotic or biotic conditions in the area (Davies et al. 2009; Popov et al. 2017; Schirmel et al. 2018), which could point to an indicative value of hoverflies in gardens. Additionally, the variation may also be influenced by the research method of photographic capture. The variation of species was not found by Owen and Gilbert (1989); they reported that hoverflies in gardens show a rather stable population.

Some species in the garden were found in only one year and ones can be designated as locally 'rare': *Dasysyrphus albostriatus*, *Epistrophe melanostoma*, *Eupeodes latifasciatus*, *Helophilus hybridus*, *Pipiza festiva*, *Pipiza noctiluca*, *Scaeva selenitica*, *Volucella pellucens*, *Xanthandrus comtus* and *Xanthogramma pedissequum*. Species which were observed every year and frequently can be designed as locally 'common': *Episyrphus balteatus*, *Eristalis pertinax*, *Eristalis tenax*, *Helophilus pendulus* (Fig. 8), *Meliscaeva auricollis*, *Neoascia podagrica* and *Syritta pipiens*. The above mentioned 'rare' species were not found in rural or urban gardens in Sweden; the 'common' species found in rural gardens in Sweden showed different results, with the exception of *Episyrphus balteatus* (Persson et al. 2020).

No non-native species were found in the garden, suggesting that a significant density of non-native flora in the investigated garden does not affect the presence of non-native hoverflies. According to Salisbury et al. (2015), non-native flora in gardens can extend the flowering season and provide additional food resources for hoverflies. On the other side, hoverflies may be more abundant on native flora (Smith et al. 2006a; Salisbury et al. 2015).

As expected, most of the species found in the garden are common or relatively common. The importance of common species for biodiversity is sometimes undervalued. While much research rightly focuses on rare species, common and thus mostly more abundant species should also be investigated for their role in biodiversity. In most biodiversity indices (Fisher et al. 1943; Simpson 1949) both species richness and abundance play important roles in population constants.

Gardens are possibly, in terms of population density, comparable to other small areas such as small woodlands. A broad European study by Valdéz et al. (2019) showed that small woodlands do not harbour many rare species but support high population densities, providing essential ecosystem services.

In the studied garden, species typical for open habitats were found (e.g., *Cheilosia albitarsis*, *Eristalis arbustorum*, *Helophilus trivittatus*, *Melanogaster hirtella*, *Melanostoma mellinum* and *Sphaerophoria scripta*) as well as species typical for deciduous forest (e.g., *Epistrophe melanostoma*, *Eristalis nemorum*, *Eristalis similis*, *Pipiza festiva*, *Volucella bombylans* and *Xanthandrus comtus*. Gardens tend to have an environmental structure similar to open woodland habitat, in terms of differentiated vegetation levels and patterns of shaded and sun-lit areas. Therefore, gardens can inhabit representative species of open woodland habitat. There is a relationship between the hoverfly presence and forest edges (Sjödin et al. 2008; Bortolotto et al. 2016; Schirmel et al. 2018), and thus the hoverflies in gardens may be considered as a natural community for forest edges.

Hoverflies as potential indicators for a Garden Health Index

There are several arguments why hoverflies could make suitable indicators for biodiversity and garden health in citizen science research. First, hoverflies are widely represented in gardens and thus accessible to a large public (Owen and Gilbert 1998; Persson et al. 2020). Second, their body size and clear patterns make most species easy to identify by photographic capture and biometrical identification, unlike many other families of Diptera (such as Chironomidae, Cecidomyiidae and Chyromyidae). This method is also an animal-friendly method of monitoring. Third, many people find hoverflies empathetic because of their aesthetic qualities due to the contrasting colours, their characteristic way of flying and the fact that they are non-biting. Fourth, hoverflies are important and economically valuable pollinators for vegetables and fruits (Jauker and Wolters 2008; Calle 2019; Cook et al. 2020). Fifth, numerous studies demonstrate the indicative value of hoverflies (Sommagio 1999; Smith et al. 2006a; Sjödin et al. 2008; Popov et al. 2017; de Groot et al. 2022). There is already some information on species able to serve as indicators of specific micro-habitats in gardens such as the presence of dead wood by the saproxylic *Xylota segnis* (van Steenis 2023) and the percentage of built space by *Melanostoma scalare* (Bates et al. 2011). However, for the purpose of developing a Garden Health Index, this specific habitat information is still limited. Disadvantages of using hoverflies as indicators include the migratory behaviour of some species (Ball and Morris 2000; Speight 2017), their possible insensitivity to heavy metals (Mielczarek et al. 2021) and their sensitivity to ambient temperatures (Aguirre-Gutiérrez et al. 2017).

A well-described and easy to repeat method of recording, and more quantitative data about micro-habitat in gardens and the autecology of hoverflies, are needed to develop a reliable Garden Health Index. A lot of information can be obtained through citizen science projects. A study of mosquitoes in Germany shows that reliable entomological data can be efficiently obtained through citizen science (Pernat et al. 2021). Additional advantages of citizen science projects include positive impact on the conservation behaviour of participants (Green et al. 2023) and in the provision of easier access to data from private properties, which are often inaccessible to most research methods (Dickinson et al. 2010). Citizen science can provide tremendous insight into the biodiversity of hoverflies and measures to increase insect diversity in gardens and backyards.

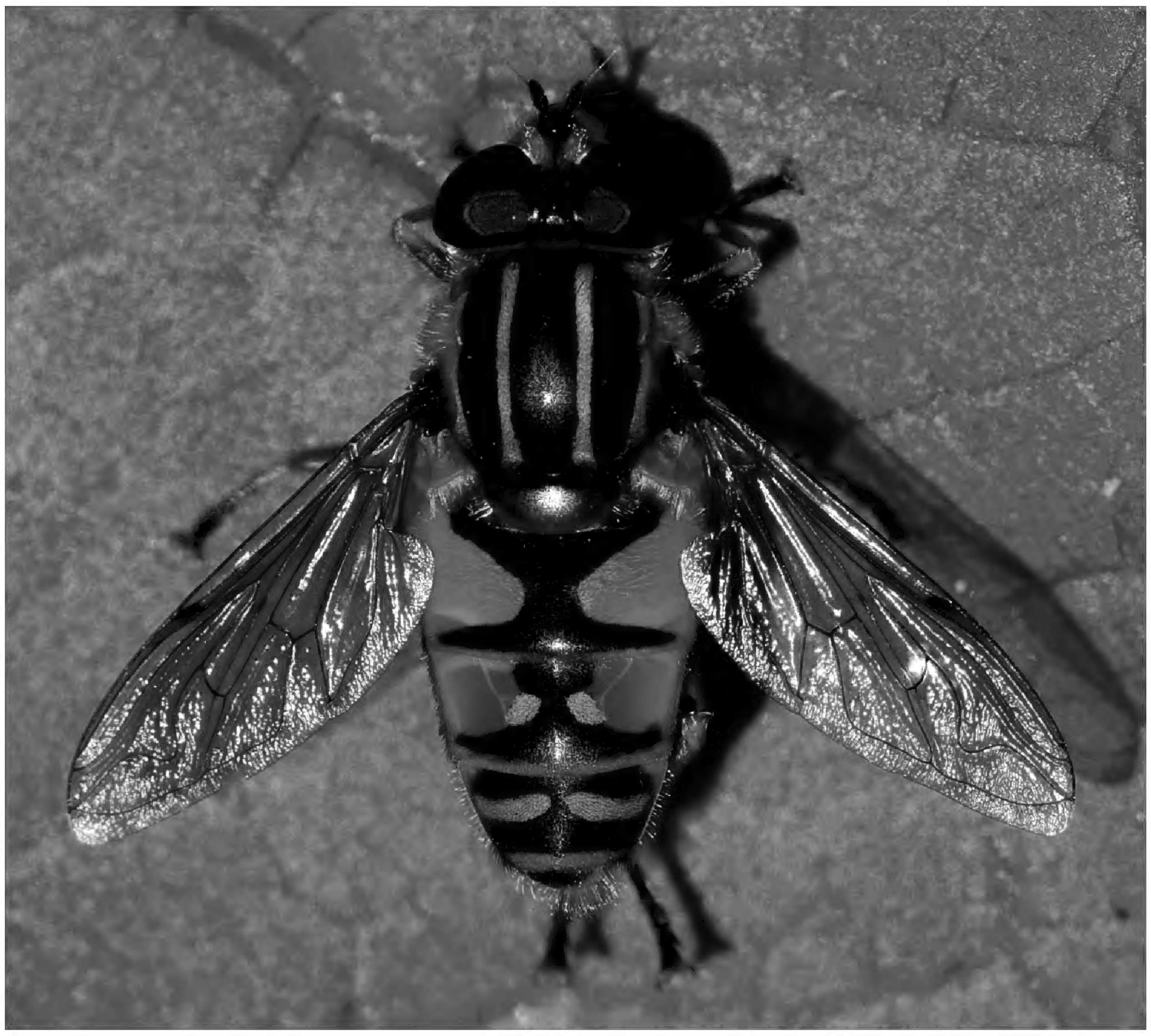

Figure 8. *Helophilus pendulus* (Linnaeus), a common hoverfly in the studied garden.

Conclusion

The species richness of hoverflies in a rural garden is considerably high. Most species in gardens are common species. Gardens can make an important contribution to increasing biodiversity in urban and rural areas. Citizen science can add value to our knowledge of hoverflies and their relation with environmental quality. This study shows that photographic capture and biometrical identification are suitable methods for citizen science projects on hoverflies.

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